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AN ADJUNCT TO SELF STUDY.

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TWO EXPERIMENTS WERE CONDUCTED TO EVALUATE A SELF-STUDY PROGRAM PREPARED WITHIN TWO OPERATIONAL FIGHTER-INTERCEPTOR SQUADRONS. BASED ON A TECHNICAL ORDER MANUAL, IT CONSISTED OF SEQUENCED MULTIPLE-CHOICE QUESTIONS WITH A SIMPLE PUNCHBOARD AS A CONFIRMING DEVICE. IN EXPERIMENT ONE, TWO OPERATIONAL SQUADRONS WERE DIVIDED INTO TWO GROUPS JUDGED TO BE AT COMPARABLE LEVELS OF KNOWLEDGE AS BASED ON A PRETEST. DURING THE 11 DAYS OF THE EXPERIMENT, THE EXPERIMENTAL GROUP SPENT JUST OVER FOUR HOURS ON SELF-INSTRUCTION, MOSTLY GOING OVER THE PROGRAM TWICE, WHILE THE CONTROL FOUND ITS CLASSROOM LECTURES INTERRUPTED BY TEMPORARY DUTY AND EXTENDED ALERTS AND SPENT SLIGHTLY MORE THAN ONE HOUR. THE EXPERIMENTAL GROUP DID BETTER ON THE POST-TEST AND LIKED THE PROGRAM AND IT WAS COMPLETELY WITHIN THE CAPABILITIES OF THE SQUADRON TO PREPARE THE MATERIALS. IN THE SECOND EXPERIMENT, THE TIME WAS CONTROLLED. THE EXPERIMENTAL GROUP WENT OVER THE PROGRAM TWICE, SPENDING AN AVERAGE OF 253 MINUTES WHILE THE CONTROL GROUP WAS GIVEN 250 MINUTES OF LECTURE OVER FIVE DAYS. AGAIN THE EXPERIMENTAL GROUP SCORED BETTER ON A POST-TEST, OVER ONE-FOURTH SCORING AS HIGH OR HIGHER THAN THE HIGHEST IN THE CONTROL GROUP. (EB)

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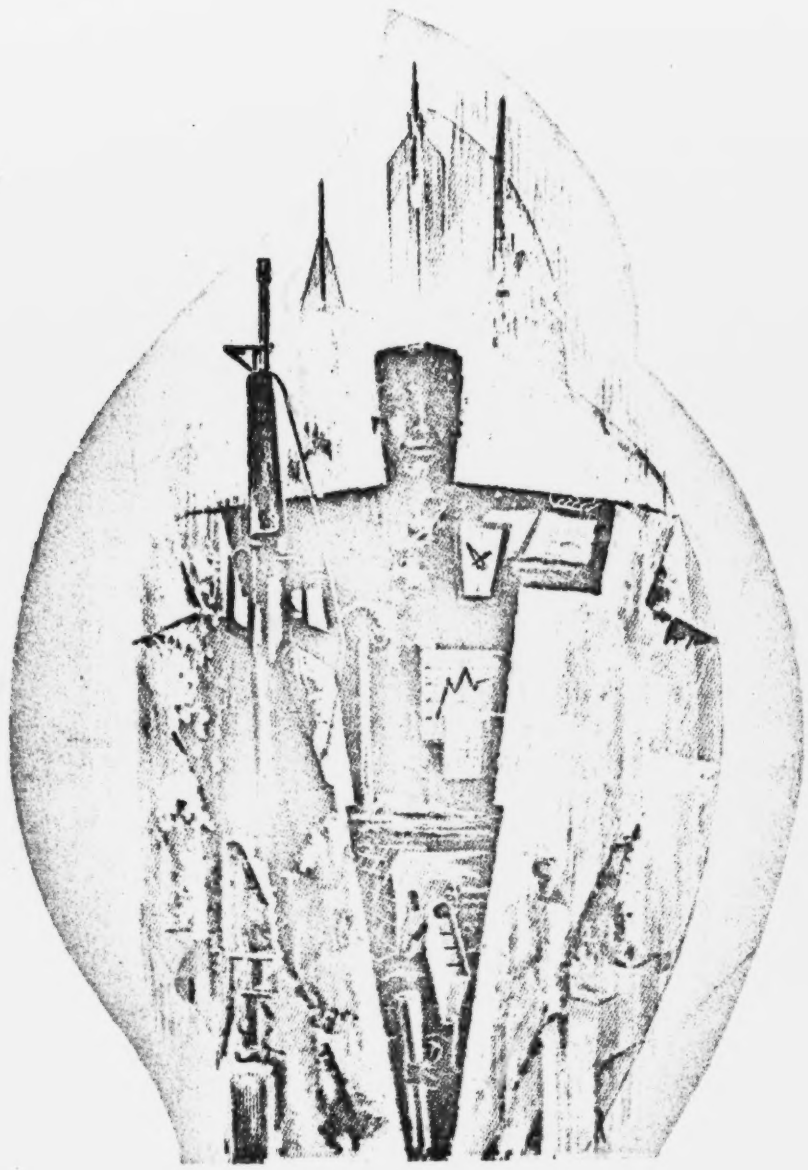

Highlighting Off-the-Job Training

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AN ADJUNCT TO SELF-STUDY

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THE TASK of an aircrew member in the modern defense structure is a highly complex one. Training toward mastery of the required skills and related knowledges is a long, arduous, and costly process.

A portion of the learned repertoire falls into a unique category. It consists of bits of information and behaviors that are not frequently used or may be in the nature of isolated factual information that does not lend itself to structuring for simple recall. Certain engineering features, some flying regulations, alternative procedures for weapons deployment due to malfunction, etc., fall in this category. While much of this seldom-needed part of the repertoire is not of a critical nature, some of it is. Circumstances may occasionally combine in such a way that their fluent use could mean the difference between disaster or safety, or an abort or successful mission.

Doctor Meyer (bachelor's and master's degrees, Colorado State; EdD, Arizona State), joined the Behavioral Sciences Laboratory, Training Research Division, in 1963, and is presently assigned to the Operator Training Branch. He has been closely associated with Air Force flying training since his experiences as a pilot during World War II. Doctor Meyer has authored programmed materials for both ATC and TAC.

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Refresher Training

Many of the skills in which an aircrew member is trained are practiced almost daily in normal mission performance. In these practiced areas, skill level and concept retention remain high. In other areas, where a task is performed only intermittently, and even then at various frequencies by the different aircrews or aircrew members, a loss in proficiency is an inevitable result. It is consequently necessary to conduct refresher training at prescribed intervals and on a continuing basis to maintain proficiency at a desired level.

Typically, conventional classroom methods are used in presenting refresher training. Lectures by training officers, factory technical representatives, and occasional guest appearances by recognized experts in a given field are the approaches most frequently used.

In light of modern educational technology, however, each of these approaches has deficiencies. Instructor limitations, the lack of any great amount of student participation, a training sched-

ule dictated by operational mission requirements, and difficulties in obtaining training aids and graphics are some generally recognized factors limiting the effectiveness of refresher training in operational units.

Improvement Needed

This nuclear age with its constant threat of vast destruction has established a requirement for the dispersal of operational units to insure a continuing defense and retaliatory capacity should an attack materialize. In view of this fact, the trend toward widespread dispersal is a growing reality, and as the trend continues, the magnitude and difficulty of conducting refresher training by conventional means becomes more and more impractical.

Programmed instructional techniques have been suggested as ways to provide refresher training in operational squadrons. However, an analysis of the more familiar techniques reveals some serious deficiencies for this application. The purpose of refresher training is review of the subject material to clarify and emphasize both the critical and not so critical information in an attempt to assure acceptable skill and knowledge levels. The aircrew members who comprise the student population are already familiar with the subject matter areas.

However, a typical cross section of aircrews reveals considerable variance in background and experience levels, as well as recency of formal training, personal habits and capabilities. It is evident that proficiency is scattered across a considerable range. The use of one or more of the familiar programming approaches appears inappropriate in that when detailed enough for the lower proficiency levels, it is much too basic for the more proficient students unless extensive branching is used. Also, the more familiar programming techniques require trained programmers and extensive time to prepare.

Self-Study Program

An adaptation of self-testing teaching technique appeared promising, and after considerable consultation with expert crew members the technique was selected for experimental trial. The technique is illustrated by FIGURE 1.

The self-study program consists of a comprehensive and carefully sequenced series of multiple-choice questions designed to cover all of the important information contained in a technical order (TO) manual. Listed with each question is the exact page and paragraph number in the TO from which the question was derived.

A simple punchboard is used as the confirming device. If the student knows the subject information and responds to the right answer it is confirmed as correct by the punchboard and the student goes on to the next question. If the student responds incorrectly on the punchboard he is directed to the page and paragraph number in the TO manual for the "remedial" instruction needed to respond correctly, after which he goes on to the next question.

Number of Advantages

A number of advantages appear inherent in this technique that seem particularly suitable to the existing training situation:

- The self-instructional sequences; i.e., the multiple-choice questions, can be quickly made up at squadron level by operational personnel without extensive training or practice in programming techniques.
- The punchboards and scoring keys can be inexpensively manufactured by squadron personnel, using readily available base facilities.

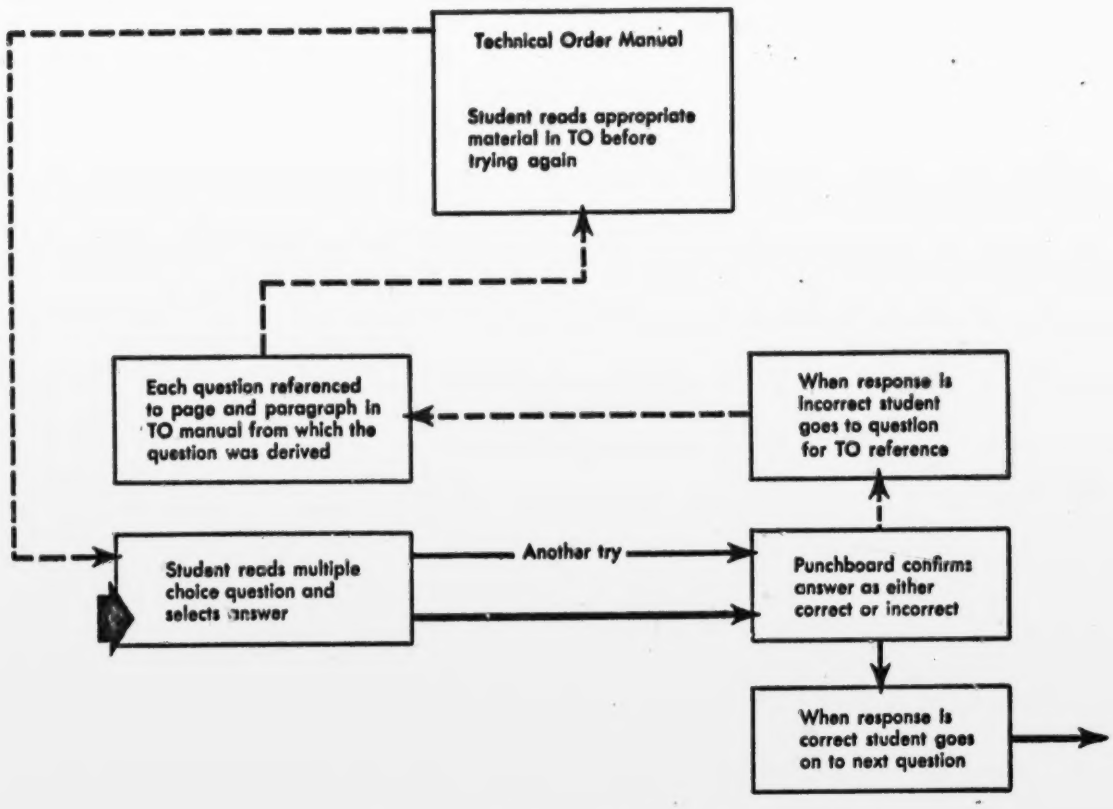
Technical Order Manual
Student reads appropriate material in TO before trying again
Each question referenced to page and paragraph in TO manual from which the question was derived
When response is incorrect student goes to question for TO reference
Student reads multiple choice question and selects answer
Another try
Punchboard confirms answer as either correct or incorrect
When response is correct student goes on to next question

Figure 1 Diagram of Adjunct Method

- It offers the student a means to progress through the instructional sequence at his own pace and in the minimum time consistent with his individual level of knowledge.
- A student is "instructed" only in areas of deficiency, thus saving both time and frustration.
- The program, punchboard, and TO can be conveniently carried to a place and used at a time of the student's choosing.
- The punchboard response-confirming device appears to have a motivational effect upon those students who use it.

Purpose of Experiment

Considering the potential value of the technique, experimental studies were conducted to evaluate the technique for operational use. More specifically, the experiments were conducted

- to determine if the punchboard technique of preparing self-instructional materials is within the capability of an operational squadron;
- to compare the effectiveness of the self-study technique with conventional classroom instruction; and
- to obtain an estimate of student reaction toward the self-study approach.

Method of Materials Development

In an attempt to assure comprehensive coverage of the subject matter to be presented, the first step was to carefully go through a specific TO manual (TO IF-101B-29, Weapons Manual) to estimate by paragraph, the number of questions needed to thoroughly cover the subject matter content. Two fighter-interceptor squadrons were then furnished the breakdown by page, paragraph, and number of questions required, together with a

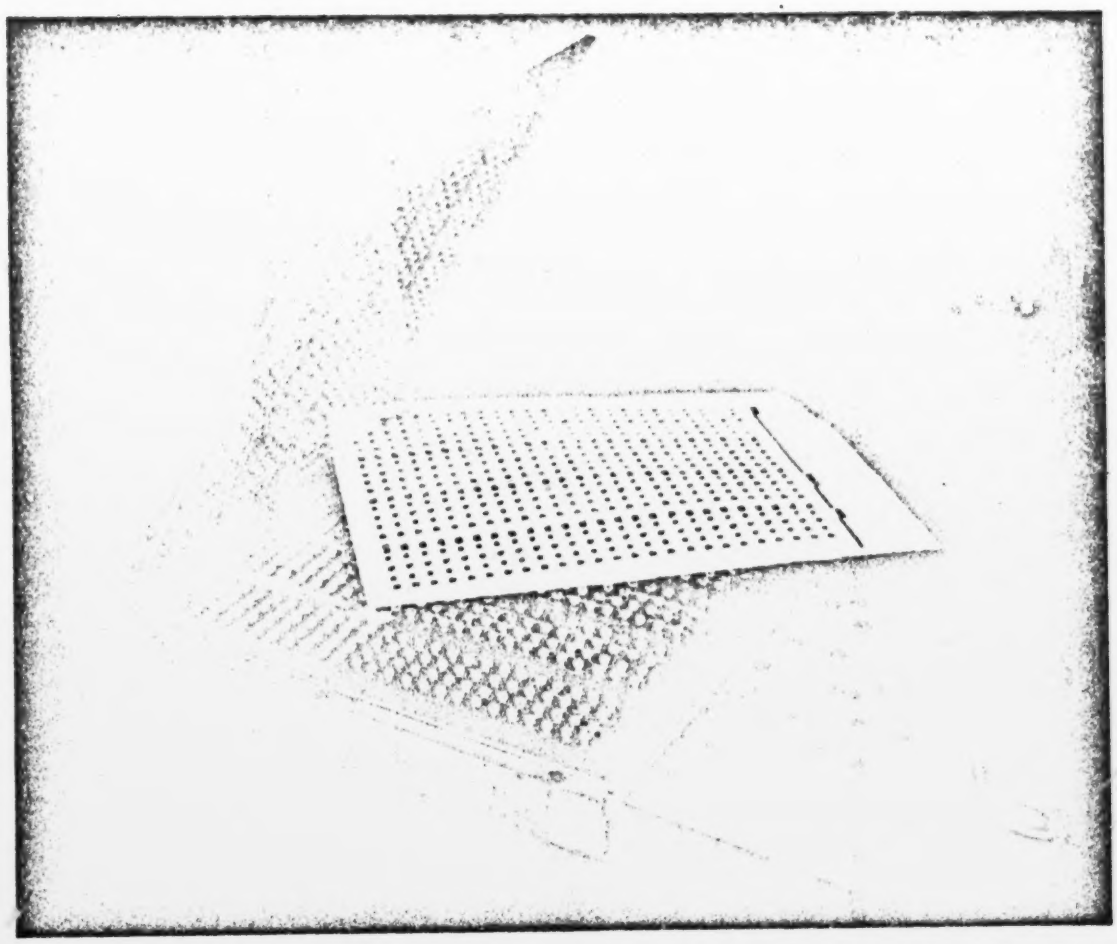

Figure 2 Punchboard with hinged top open receives the answer sheet. The metal sheets beside the punchboard are answer keys that can be inserted in the punchboard to accommodate more questions.

request that each of their qualified officers be assigned the responsibility for making up 10 multiple-choice, four alternative-response questions covering the specified paragraphs and marking the correct answer as well as the page and paragraph number to which each question had reference. Guidelines for the preparation of questions were drawn up and furnished each officer. An extensive item pool of questions, suitably referenced, was thus obtained. Questions were selected from this pool, edited as necessary, and sequenced to form the self-study program.

The item pool also provided the source from which 50 questions were drawn to make up the criterion examination. Due care was taken to assure that a representative sampling of the subject matter was covered and also to avoid duplication of any item used in the instructional program. The same items used for the pre-training test were presented in reverse order as the post-training test.

The punchboards used as response-confirming devices were designed and fabricated by an operational squadron. The punchboards were designed to use metal slide-in answer keys to accommodate any number of instructional test items by merely changing answer keys. A conception of the construction details can be obtained from FIGURE 2.

EXPERIMENT I

The experiment was initiated with the administration of a 50-item multiple-choice pretraining test to the two participating squadrons. (Henceforth, the squadron given instruction by the self-study method will be referred to as the experimental (E) group; the squadron receiving conventional classroom instruction will be referred to as the control (C) group.) The purpose of the pretest was to estimate the comparability of the two groups on the basis of knowledge. The results are summarized in TABLE 1.

Table 1

Experiment I pretest

	E Group	C Group
Number of subjects	34	30
Mean raw score	34.41	32.73
Mean score in percent	68.82	65.46
Standard deviation	4.76	5.84
Standard error (mean)	.82	1.07

A t-test of statistical significance was applied to these data. The obtained t-value indicated no significant difference between the means of the two groups.* Upon this basis the two groups were judged to be at comparable levels of knowledge prior to the training prescribed.

Instruction Time

Subjects in the experimental group were instructed to work through the self-study booklet at least once during the 11 days scheduled for the experiment. Personnel in the control group were to be scheduled for classroom instruction covering all of the subject material during this period.

Members of both groups were instructed to keep accurate records of the amount of time individually spent in their respective modes of instruction. Although the resulting records are probably more in the category of time estimates than precise measures, they are included in this report to form a basis for comparison. Subjects in the experimental group averaged four hours and 13 minutes of self-study compared to an average of one hour and 13 minutes of classroom instruction for subjects in the control group. Most of the subjects in the experimental group reported going through their self-study materials twice.

A number of factors intervened which interrupted classroom schedules for the control group (temporary duty, extended alerts, assignments to ferry aircraft, etc.). This, however, is a normal condition in an operational squadron faced with mission responsibilities. The experimental group, though faced with the same responsibilities, was able to devote an average of almost four times more time on instruction than the control group due to the self-study feature; i.e., subjects could study at a place and time of their own individual choice, independent of any group effort or fixed schedule.

Post-training Test

A post-training test was administered to both groups 11 days after initiation of the project. The results are summarized in TABLE 2.

The 3.95 t-value obtained from these data indicates a difference between means that is significant beyond the .001 in favor of the experimental group.

* EDITOR'S NOTE: A t-test is a statistical procedure used to determine whether the difference between the means of two groups is real and not an observation obtained by chance. With the use of prepared tables, the t-value is evaluated in terms of the probability of its occurring by chance alone. Since the t-value reflects the degree of difference between the two means, the significance level of .001 means that only once in 1000 would such a difference be expected to occur by chance alone. The difference, therefore, is attributed to the difference between the experimental and control groups.

Immediately following the post-training test, subjects in the experimental group were asked to complete a questionnaire in an attempt to gain an estimate of the degree of acceptance of the self-study technique. Most of the responses indicated a high degree of acceptance and enthusiasm for the self-instructional technique.

Table 2

Experiment I post-training test

	E Group	C Group
Number of subjects	34	30
Mean score	41.44	35.97
Mean score in percent	82.88	71.94
Standard deviation	4.55	6.27
Standard error (mean)	.784	1.143

Experiment I Findings

The findings of this experiment indicate

- the preparation of the punchboards and self-instructional materials is well within the capabilities of an operational squadron;
- the self-study technique is superior to conventional classroom refresher training as measured by the post-training examination; and
- the subjects who participated in the post-training program were generally enthusiastic in support of the self-study method.

The disproportionate study times (one hour and 13 minutes conventional, four hours and 13 minutes self-study) are realistic comparisons that emphasize the difficulty of conducting group instruction under operational conditions. The fact that almost four times more study time was available to subjects engaged in self-study is a decided advantage over conventional instruction. From an operational viewpoint the study time disparity marks the self-study method as definitely advantageous; experimentally, however, a question arises concerning how well the self-study method would compare if the same amount of time were devoted to classroom instruction. On this basis a decision was made to repeat the experiment holding the time factor constant.

EXPERIMENT II

Two operational squadrons were again identified as experimental participants. As in the first experiment, the squadron assigned the self-study technique will be referred to as the experimental group, with the conventionally taught squadron as the control group. Both groups participating in the experiment were pretested using the same 50-item multiple-choice test used in the first experiment to determine the comparability of knowledge levels prior to training. The results of the pretraining test are summarized by TABLE 3. The two groups were judged comparable upon finding a nonsignificant t-value.

The control group was then given a 50-minute instructional period each day for five consecutive days. The lecture method was utilized for this instruction by a well-qualified fighter-interceptor weapons instructor.

Table 3

Experiment II pretraining test

	E Group	C Group
Number of subjects	26	24
Mean score	34.19	32.04
Mean score percent	68.38	64.08
Standard deviation	4.89	4.62
Standard error (mean)	.96	.94

Comparable Study Times

Subjects in the experimental group were directed to work through the self-study program twice during the experimental period and to individually maintain accurate records of the amount of time so spent. It had been determined in the previous experiment that approximately 250 minutes were required. The result was comparable training times for the two groups. Subjects in the experimental group spent an average of 253 minutes in self-study, compared to 250 minutes of classroom instruction for the control group.

The post-training test was administered to both groups at the completion of the instruction periods. The results are shown in TABLE 4.

Table 4

Experiment II post-training test

	E Group	C Group
Number of subjects	26	24
Mean score	40.89	35.79
Mean score percent	81.78	71.58
Standard deviation	3.79	5.24
Standard error (mean)	.74	1.07

The obtained t-value of 3.95 indicates a difference between the means that is significant at the .001 level in favor of the experimental group. The gain in achievement over the pretest was 13.40 percentage points for the experimental group, compared to a 7.50 percentage point gain for the control group.

As in the first experiment, a student reaction questionnaire was administered to subjects in the experimental group. The results again were generally quite favorable toward the self-study technique.

An examination of the frequency distributions of the scores obtained by the two groups reveals some interesting differences. Twenty-seven percent of the subjects in the experimental group scored as high or higher than the highest score made in the control group. Only 17 percent of the control group scored at or above the mean of the experimental group while 88 percent of the experimental group scored above the mean of the control group. Twenty-one percent of the subjects in the control group scored lower than the lowest score made in the experimental group. The scores ranged from 32-49 for the experimental group compared to a range of 23-44 for the control group.

Findings Discussed

The statement that "no single training technique or method is universally adapted to all training situations" would probably be argued by no one. There are, however, classes or categories of training situations to which certain approaches seem particularly appropriate.

The self-study technique used during this study appears suitable to training needs in the categories of review and refresher training. The use of punchboards or other response confirming devices is not unique in the technology of training. A history of such contrivances is readily found in existing literature (1). This study emphasizes the potential of this method in a "do-it-yourself" environment.

The modern defense structure with its isolated site and dispersal requirements is such that conventional group instruction, after an individual is assigned to a command, is not practical in many cases. Inappropriate facilities, the nature of the assigned mission, limited operating budgets, and the lack of trained instructor personnel conspire to rule out on-site

group instruction as an effective approach to continuation or refresher training. Self-instruction appears to be the best if not the only means of providing this necessary function.

Limited Effectiveness

Conventional manuals, texts, and technical orders are provided for most of the required fields of knowledge, but the mere reading, even of the best of these when considered as the only means of instruction, is of limited effectiveness. The new and rapidly developing field of programmed instruction is proving an effective means of solving the problems of self-instruction. However, the task of programming is a costly and time-consuming process requiring considerable training for mastery.

Moreover, this degree of pedagogical thoroughness and refinement may not be necessary in some areas. Most refresher training of the kind required by the operational commands appears to be of this type. Here the student has already been trained or is experienced in the required tasks. To be maximally effective, instruction for this person should center only in areas which have been forgotten, partially forgotten, or confused through lack of use. To spend time, money, and effort in instructing a person concerning material he already knows is pointless and as frustrating to the student engaged in self-study as it is to a student in a conventional classroom.

Objections Avoided

The adjunct techniques used in this study seem to avoid many of these objections. By utilizing existing publications as information sources the most expensive single cost is avoided. The questions and response-confirming devices can be quickly and easily made up without extensive training in programming techniques. It is suitable for students at

Flying officers find the adjunct program to be a time saving method of study.

heterogenous levels of knowledge. Since students are instructed only in areas of deficiency as confirmed by their responses and, because it provides direct reference to the page and paragraph number in the test to correct the deficiency, it is economical in its requirements on student time and effort.

It is easily portable and can be studied at a time and place of the students' own choosing. It is self-paced. It can be accomplished in short settings since the steps (questions) are separate items rather than continuous discourse. The use of the punchboard seems to have motivating aspects, apparently adding some features of game playing. Most students indicated they liked it as a self-study method. Last, and perhaps most important, it is an effective training technique.

These features provide a powerful argument for careful consideration of this technique by operational commands faced with refresher training requirements. The cost and ease of implementation are minimal in view of the findings and conclusions of this study.

Conclusions Warranted

The findings of the two experiments conducted during this study would seem to warrant the following conclusions:

- The preparation and administration of the self-study technique are entirely within the capability of an operational squadron with only a minimum amount of guidance.
- In the operational setting, the self-study technique is superior to conventional classroom methods in its effectiveness as a means of presenting refresher training.
- Students are favorable in their acceptance of the self-study presentation of refresher training.

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